

Conference Paper

Ship accident prevention under organizational influences on the ship operation by using gap analysis

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Abstract

By using Human Factors Analysis and Classification System (HFACS), the identification of human factor could be analyzed and classified to find out some prevention actions against ship accident. The human factors may play an important role in ship accident as the consequences of the ship operation is the risk that can potentially happen. One of the layers of HFACS is the organization influences which consist of factors such as human resources, organization climate, and policies. The objective of this reserach was to identify and to explore the perception and the expectation of the ship officer related to organizational influences by applying gap analysis method. The questionnaire consisted of 28 questions divided into three categories. The result showed that the policies factor has higher gap compared with the others factors. The result indicated that the shipping company need to pay more attention to the condition of organizational policies before recruiting new crews, as well as the policies related to the monitoring while they are on board and after they return home. Further research on similar method on others layers of HFACS need to be carried out in order to obtain more detailed descriptions on ship accident prevention strategies.

Keywords: ship safety, organizational influences, gap analysis,

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1. Introduction

Indonesia is an archipelagic country as two-third of its territory is water. Thus, transportation facilities which connect the islands are considered vital. In this case, among other means of transportation, ship is considered as the main sea transportation for its effectiveness to transport large numbers of goods. Moreover, its possibility to serve several seaports at the same time makes this transportation low-costed. However, in regard to its operation, potential risks can always possibly occur, one of which is ship accident. This risk exists as the consequence of a transportation system where potential irregularities such as human factors, hardware, software and the environment exist. Based on the ship accident data and records, there are several accident categories

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of sea accidents including sinking, collisions, and fires. These ship accidents show the real condition of the sea transportation system especially those related to shipping safety. The number of sea accidents in Indonesian waters investigated by the National Transportation Safety Committee (NTSC - Indonesian: Komite Nasional Keselamatan Transportasi, KNKT) from 2010 to 2016 is presented in Figure 1.

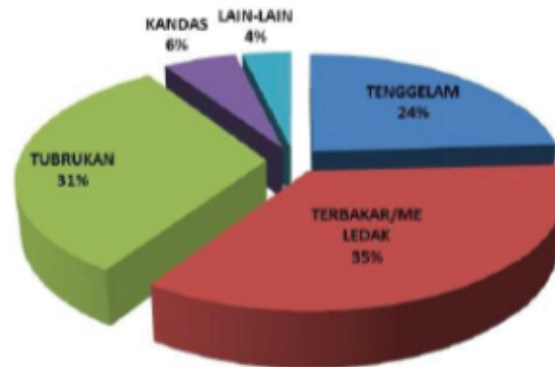


Figure 1: Ship accident statistics in Indonesia in 2010-2016 (Source: Media Released by KNKT in 2016).

Human error highly contribute to the accidents occurred in land, sea, and air transportation reaching 60-80% as well as in the health, mining, and manufacturing industries (Trans, 2016). According to the Minister of Transportation, 88% of ship accidents in 2016 were caused by human error (Arif, 2016). Generally, it is human’s nature to make mistakes and error. The question is how to reduce the errors and minimize the impacts affected. The mitigation of the risk of accidents is what urgently needed to implement.

Previous research on the causes of ships sinking due to human factors, by using the HFACS method (Human Factor Analysis and Classification System), found that most accidents were caused by organizational influences, followed by preconditions for safe act, unsafe supervision, and unsafe act, themselves. (Antoro & Priadi, 2016). The findings were presented in Figure 2.

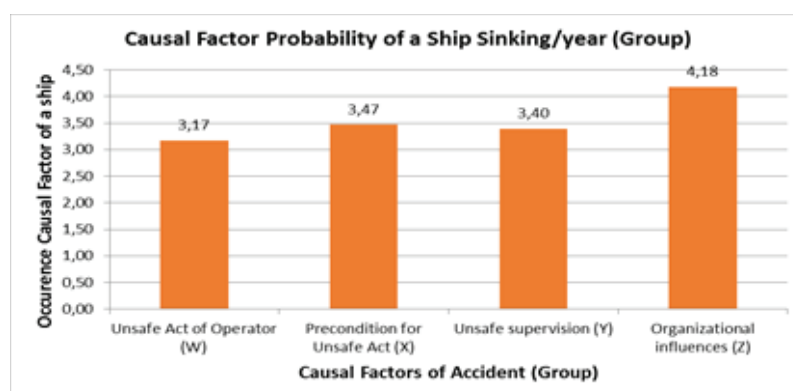


Figure 2: Probability Diagram of Ship sinking (Source: Antoro & Priadi, 2016).

This research was conducted to follow up the previous research focused on human resources as the sea transportation manager and ship operators related to ship accident factors (Antoro & Priadi, 2016). The previous research identified factors which caused sea accidents by using HFACS method whereas this research was aimed to determine the gap level of factors which caused ship accidents on organizational influence category.

2. Literatur Review

Human error is defined as an occurrence of deviation carried out by humans which causes a system failure. Human error significantly contributes to ship accidents since most equipments, organization, and operations are handled by humans, even though the number of the involvement is surprising (Reason,1990). The series of accidents begins with the impact of a decision in the organization (planning, scheduling, forecasting, designing, specifications, communication, procedures, maintenance, etc.). The decision is a product which is influenced by the financial and political constraints of the company and it is determined by factors which can be controlled by the manager (Reason, 1990). Thus, it can be concluded that within an incident, someone as an attribute of a system cannot be fully blamed since it is an integrated system.

HFACS is a model based on CHEESE and was first introduced by James Reason (1990). Reason was inspired by Switzerland's pieces of cheese each of whose layer has holes in rows. This model elaborates on the division of human error consisting of latent/ hidden errors and active/ real errors. Latent errors are errors made by humans which indirectly contribute to accidents while active errors are errors caused by humans which directly cause accidents. HFACS divides human error into four levels: (1) unsafe acts of operator, (2) precondition for unsafe acts, (3) unsafe supervision, and (4) organizational influence. The model is illustrated as follows in Figure 3.



Figure 3: Reason's Cheese Model.

3. Methods

This research only applied the organizational influence of HFACS. In order to collect the data, questionnaires were spread to the experts in shipping sector, especially commercial shipping officers who had numbers of sailing experiences. The questionnaire consisted of 28 questions divided into 3 groups. The first group consisted of 11 questions and was related to human resources factor. The second group belonged to organizational climate factor and consisted of 11 questions. The third group was policy factor group and consisted of 6 questions. The questionnaire itself consisted of two parts: (1) perception and (2) expectation. The example of the questionnaire is presented in Table 1.

TABLE 1: Questionnaire Design.

PERSEPSI					Pernyataan	HARAPAN				
STS	TS	N	S	SS		STP	TP	N	P	SP
					A. HUMAN RESOURCES /					
					1))Sumber daya manusia dapat mempengaruhi terjadinya kecelakaan kapal (Human resources influence the occurrence of ship accidents)					
					2))Penyeleksian pegawai/crew kapal telah sesuai dengan prosedur (Crew enrollment system has been based on the procedure)					
					3))Training untuk crew kapal sudah dilaksanakan sesuai kebutuhan dan prosedur (Training to the crews has been carried out based on necessity and procedure)					
					4))Bentuk atau desain kapal berpengaruh terhadap keselamatan (The vessel design affect on its safety)					

After obtaining the research data, a validity test, reliability test, and GAP analysis were conducted. Validity test is used to measure the validity of the questionnaire. Questionnaire is stated as valid if the questions are able to explore what is going to be measured. The validity test was done by using ratio *r*. If *r* value of each item in the questionnaire is positive and has a higher value, the questionnaire item is valid. (Sunyoto, 2009 & Sekaran, 2006).

Reliability is an instrument used to measure the questionnaires which are regarded as the variable indicators. A high reliability measurement means that the measurement is able to provide reliable results. Questionnaire items are said to be reliable if the respondent's answers to the questionnaire are consistent. In order to determine the reliability coefficient, Alpha Cronbach was applied. If the Alpha Cronbach value is more

than 0.60, the variable is reliable. (Sunyoto, 2009 & Sekaran, 2006). In this research, SPSS version 18 was also used to proceed the respondent data.

GAP analysis is defined as a method or tool to determine the performance level of an institution (Muchsam, Falalah, & Irianto, 2011). In other words, GAP analysis is a method used to determine the performance of a running system with a standard system. Generally, the performance of an institution can be reflected through its operational systems and strategies. On the other hand, specifically, it can be stated that the performance level can be measured through the gaps which are created between perceptions and expectations. In order to do GAP analysis, the difference of the average value of both perception and expectation item is calculated by using expectation value - perception value. $Gap = P \text{ (perception)} - E \text{ (expectation)}$ (Wijaya, 2011).

4. Results and Discussions

In this research, the respondents consisted of 35 people who had working experiences in the shipping industry, especially officers on commercial vessels. The respondents' age ranged from 36 to 40 years old with a frequency 37% of the total respondents. Furthermore, in regard to respondents' formal education level, 36% of them were diploma 3 (associate's degree) and 11% of them were high school graduate. Related to their level of expertise certificate, 94% of the respondents were ATT-III seafarers' expertise certificates holders and 6% were ATT-II expertise certificate holders. It was also found that related to respondent's job experience, 43% had experiences on board as second engineer and 31% of them had experience as a chief engineer.

Some of the respondents also had worked on foreign vessels. 37% of respondents had worked on Indonesian-flagged vessels, 33% of them said that they had experience working on Asian-flagged vessels, and only 6% had worked on American-flagged vessels. According to the types of vessels they had worked on, 34% of the respondents had working experience on general cargo ships, 24% of them had worked on tug or supply vessels, 14% of them had experience working on bulk vessels, 9% had worked on tankers, and a small percentage of them had worked on passanger and chemical tanker vessels.

A validity test was carried out for questions related to perception and hope. Among the 28 questions (variables) which were interrelated, the validity test result for perception was found as presented in Table 1. Below, within the Ptotal column, we could find Pearson Correlation value and the significance marked with **. For example, question for perception no 1 (PV1) shows that the question was valid with Pearson correlation

value of 0.401 * and was significant. Another example, in question number 2 (PV2), questions with invalid results were found.

TABLE 2: Perception Validity Test Results.

		PV1	PV2	PV3	PV23	PV24	PV26	PV27	PV28	Ptotal
PV1	Pearson Correlation	1	,122	,206	,487**	,232	,405*	,163	,381*	,401*
	Sig. (2-tailed)		,487	,236	,003	,180	,016	,351	,024	,017
	N	35	35	35	35	35	35	35	35	35
PV2	Pearson Correlation	,122	1	,567**	,313	-,103	-,090	-,152	-,203	,166
	Sig. (2-tailed)	,487		,000	,067	,557	,606	,383	,242	,341
	N	35	35	35	35	35	35	35	35	35
PV14	Pearson Correlation	-,394*	,145	,360*	,258	,217	,038	,132	,015	,287
	Sig. (2-tailed)	,019	,406	,034	,135	,210	,828	,450	,932	,094
	N	35	35	35	35	35	35	35	35	35
PV28	Pearson Correlation	,381*	-,203	-,019	,265	,550**	,704**	,694**	1	,652**
	Sig. (2-tailed)	,024	,242	,913	,123	,001	,000	,000		,000
	N	35	35	35	35	35	35	35	35	35
Ptotal	Pearson Correlation	,401*	,166	,485**	,585**	,675**	,717**	,677**	,652**	1
	Sig. (2-tailed)	,017	,341	,003	,000	,000	,000	,000	,000	
	N	35	35	35	35	35	35	35	35	35

Furthermore, based on the overall results of the validity test for perception questions, there were two invalid questions as described in Table 3. Any corections to the invalid questions were needed.

TABLE 3: Invalid Perception Questions.

No.	QUESTION
PV2	Penyeleksian pegawai/crew kapal telah sesuai dengan prosedur (Crew enrollment system has been based on the procedure)
PV14	Tingkat ketegasaan pimpinan kepada seluruh crew kapal mentaati peraturan yang berlaku (Assertiveness level of the leader to make the crews obey the rules)

After the validity test, a reliability test was carried out. This reliability test was aimed to find the correlation between the total number of even-numbered questions (Ptogenap) and odd-numbered questions (Ptoganjil). The correlation value of the Pearson test was 0.903** indicating that there was a significant correlation. The detailed test results are presented in Table 4.

The validity test was then conducted to the expectation questions. The question consisted of 35 questions (variables) which were interrelated. The test result are presented

TABLE 4: Perception Question Reliability Test Results.

Correlations		Ptoganjil	Ptogenap
Ptoganjil	Pearson Correlation	1	,903**
	Sig. (2-tailed)		,000
	N	35	35
Ptogenap	Pearson Correlation	,903**	1
	Sig. (2-tailed)	,000	
	N	35	35

** . Correlation is significant at the 0.01 level (2-tailed).

in Table 4. Below, it can be seen that in the Etotal column, there are Pearson Correlation values and significance marked with **. For example, for expectation question number 27 (EV27), the test showed that the question was valid with a Pearson correlation value of 0.396 and was indicated as significant. Another example, in question number 28 (EV28), the results also showed that it was valid. However, similar to the validity test on the perception question, some invalid questions were also found within these expectation questions e.i. question number 1 (EV1). Some questions were indicated invalid.

TABLE 5: Expectation Validity Test Results.

		EV1	EV2	EV26	EV27	EV28	Etotal
EV1	Pearson Correlation	1	-,186	,051	,220	,072	,124
	Sig. (2-tailed)		,285	,772	,205	,682	,479
	N	35	35	35	35	35	35
EV2	Pearson Correlation	-,186	1	-,206	-,019	-,093	,127
	Sig. (2-tailed)	,285		,236	,915	,597	,468
	N	35	35	35	35	35	35
EV27	Pearson Correlation	,220	-,019	,524**	1	,707**	,396*
	Sig. (2-tailed)	,205	,915	,001		,000	,018
	N	35	35	35	35	35	35
EV28	Pearson Correlation	,072	-,093	,354*	,707**	1	,366*
	Sig. (2-tailed)	,682	,597	,037	,000		,031
	N	35	35	35	35	35	35
Etotal	Pearson Correlation	,124	,127	,540**	,396*	,366*	1
	Sig. (2-tailed)	,479	,468	,001	,018	,031	
	N	35	35	35	35	35	35

Furthermore, based on results of the validity test for the expectation questions, four invalid questions were found as described in Table 6 below. These invalid questions indicated that the questions needed to be corrected.

TABLE 6: Invalid Expectation Questions.

NO.	QUESTION
EV1	Sumber daya manusia dapat mempengaruhi terjadinya kecelakaan kapal (Human resources possibly influence the occurrence of ship accidents)
EV2	Penyeleksian pegawai/crew kapal telah sesuai dengan prosedur (Crew enrollment system has been based on the procedure)
EV4	Bentuk atau desain kapal berpengaruh terhadap keselamatan (Ship design affects on the ship safety)
EV19	Tingkat kebisingan di atas kapal masih di bawah maximum level yang ditetapkan (The ship noise level is still below the maximum specified level)

After carrying out the validity test on expectations, a reliability test was also performed on the expectation questions. This reliability test was aimed to identify the correlation between the total number of even-numbered questions (Etogenap) and the odd-numbered questions (Etoganjil). Based on the analysis, the correlation value of the Pearson test was 0.898** and indicated a significant correlation. The detailed test results are presented in Table 7 as follows:

TABLE 7: Expectation Question Reliability Test Results.

Correlations		Etoganjil	Etogenap
Etoganjil	Pearson Correlation	1	,781**
	Sig. (2-tailed)		,000
	N	35	35
Etogenap	Pearson Correlation	,781**	1
	Sig. (2-tailed)	,000	
	N	35	35

** . Correlation is significant at the 0.01 level (2-tailed).

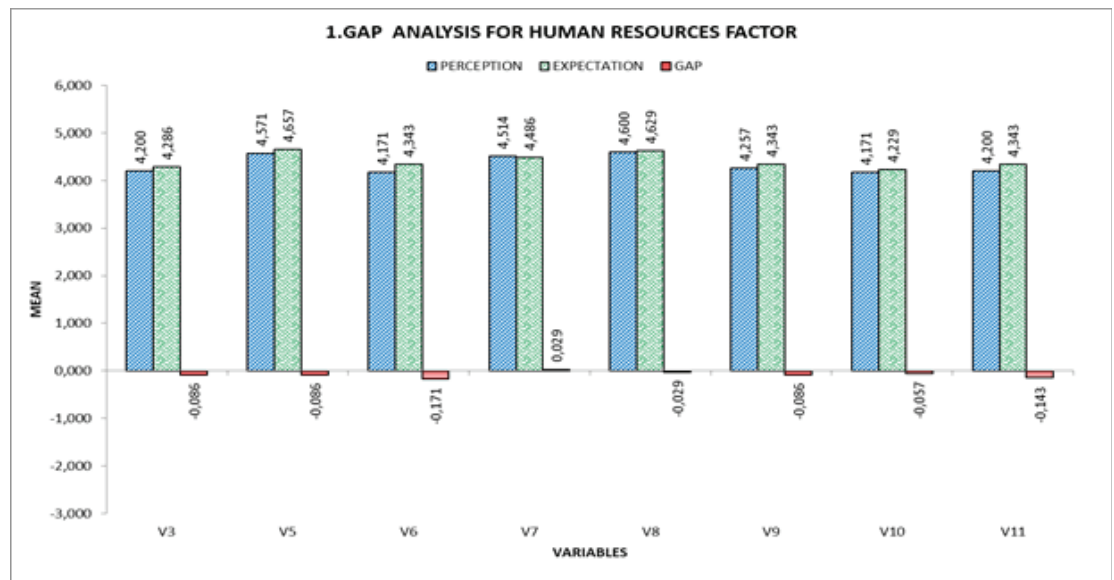


Figure 4: GAP Analysis for human resources factor.

In this research, after carrying out validity and reliability test, GAP Analysis was also performed. The GAP analysis was carried out by comparing the mean/ average value of both perceptions and expectations. In this case, GAP analysis began with the questions of the first group: human resources factor. This group initially consisted of 11 questions, but after the validity and reliability test, only 8 questions were left. The results are presented in Figure 4 below:

Based on the results of GAP analysis presented by the bar diagram in Figure 4, it was found that there were gaps in the questions/ variables V3, V5, V6, V7, V8, V9, V10 and V11. A fairly high gap was found in V6 and V11. Question V6 itself was about the analysis of ship damage whether it has been carried out properly. V11 was about the scheduled ship operation which would affect the speed and safety of the ship.

The next GAP analysis was carried out to the question of the second group: organizational climate factor. Initially, this group consisted of 11 questions, but after validity testing and reliability testing, only 9 questions were left. The results are presented in Figure 5.

Based on the figure above, it was found that there were gaps in the questions/ variables V12, V13, V16, V17, V18, V20, V21 and V22. In question V13 and V18, the gaps were fairly high. V13 was related to the existence of a communication system of ship operation in the company which has met the standard. On the other hand, V18 was related to the idea that the ship was clean and comfortable and provides adequate facilities (bedrooms, internet).

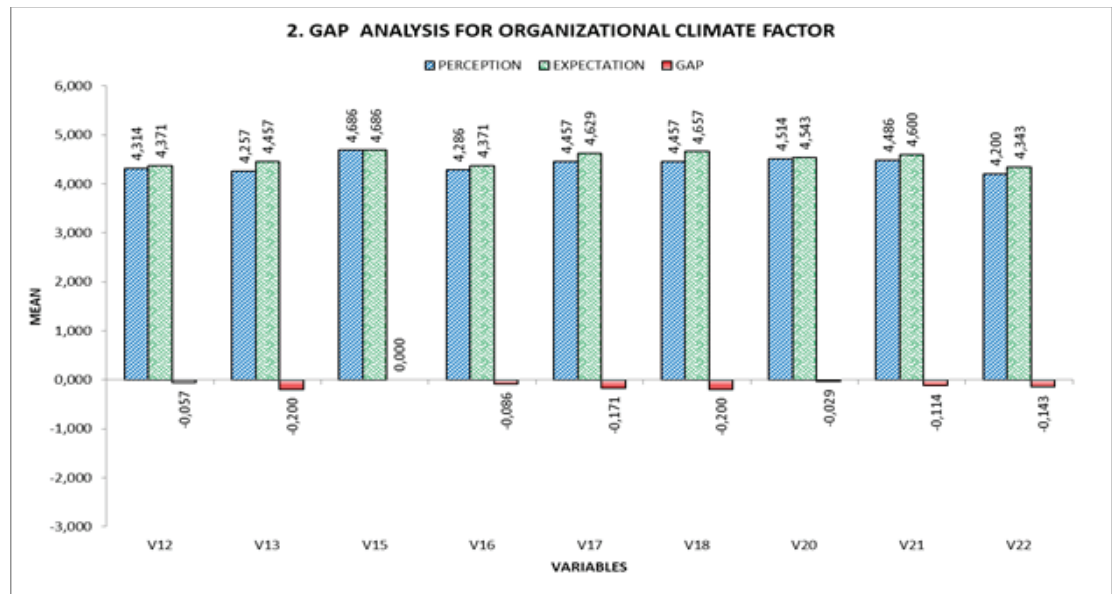


Figure 5: GAP Analysis for organizational climate factor.

The next GAP analysis was done to the questions in the third group: policy factor. In this group, there were 6 questions both before and after the validity and reliability test since they were all proven as valid. The results are presented in Figure 6.

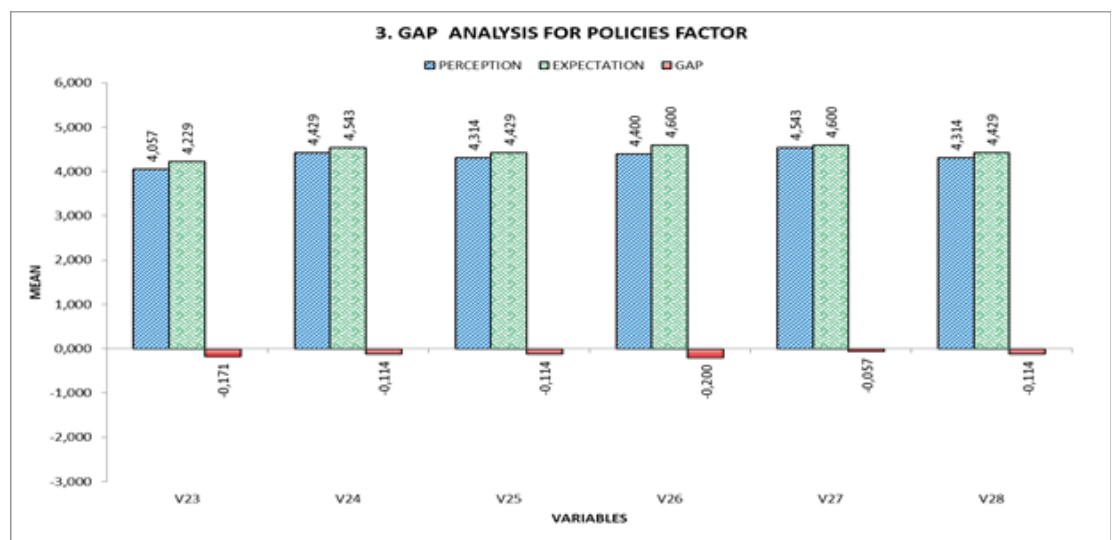


Figure 6: GAP Analysis for policies factor.

Based on the figure above, it was found that there were several questions/ variables which had gaps: V23, V24, V25, V26, V27 and V28. The highest gap occurred in questions V26 and V23. The question V23 was about a vigorous promotion given by the ship company to persuade the seamen. On the other hand, question V26 was related to an investigation of the ship accident. Based on the analysis, it was found that all accidents occurred on board were overcome or monitored by using a thorough

investigation system in order to determine the causes of the accident. It was also used to determine what actions should be carried out based on the investigation result.

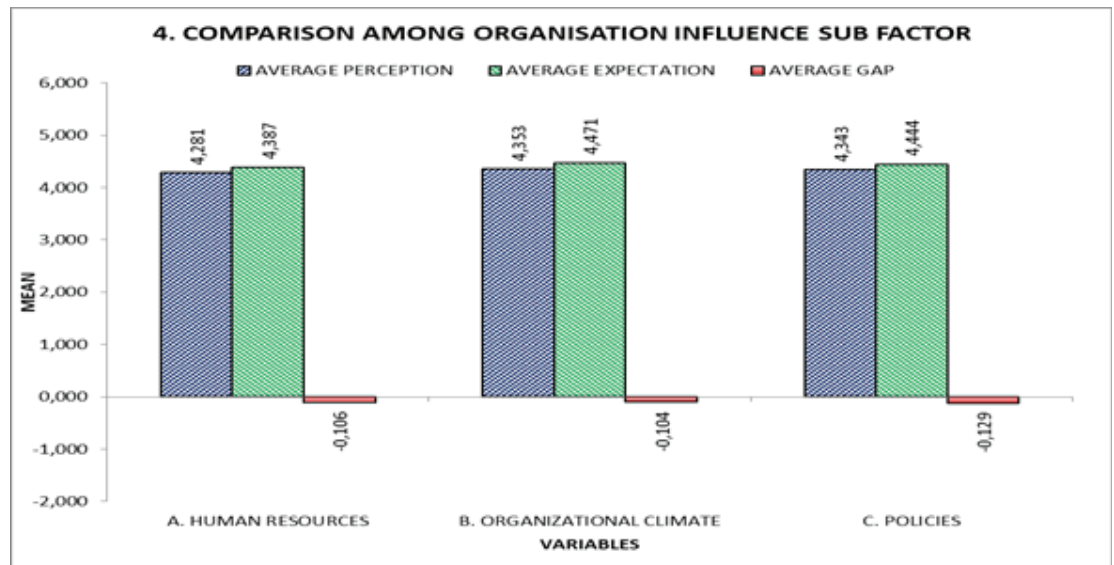


Figure 7: GAP Analysis among organization influence sub factor.

Figure 7 above presents the results of GAP analysis between groups of factors: (1) Human Resources, (2) Organization Climate, and (3) Policies factor. Based on the analysis, it was found that the highest gap occurred in the policies factor followed by the Human Resources factor and and Organization Climate factor.

5. Conclusion

The purpose of the research was to identify the gap of a ship operating system carried out by deck officers. The gap was obtained through GAP analysis by using a questionnaire which explored respondents' perceptions and expectations of the ship's operating system. In this case, the GAP analysis only examined the factors which were part of HFACS model: organizational influences. Based on the analysis, it could be concluded that there was a high gap within the policies factor compared to the human resources factor and the organizational climate factor. Thus, based on the findings, it was concluded that all parties performing the ship operating system need to carry out some preventive actions and mitigation against these factors. The researcher believe that this research was not flawless that it has limitations. Thus, it is recommended that a further, more in-depth research on the similar topic definitely needs to be carried out.

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